was by far the most abundant colcopterous insect I met with. It is not at all gregarious, but single individuals are seen resting on the leaves of trees that overhang the sides of the roads; scarcely a shrub being without several for miles together.

98. *Elaphidion spinicorne.* From the creaking sound made by this species in common with many others of the *Longicornes*, it is commonly known by the name of the Fiddler. It is one of those species whose activity is not confined to any particular season or locality, but is a common visitor at all times, flying in at open windows, and crawling around the candle-shades, or up the walls, in the evening. The spinous processes of the antennæ and of other parts are so long and sharp that they pierce the fingers when the insect is handled, though ever so tenderly.

99. *Elaphidion* 6-*fasciatum.* Very common on the leaves of low trees by the sides of the Hampstead Road throughout June.

100. *Elaphidion bidens*? Rare: a specimen taken at the Hampstead Road near the end of June.

101 to 104. *Elaphidion* (sp. near *insulare*). And three other species; occurring sparingly in June, on the Hampstead Road, and occasionally flying in at the open window at Content, in the evening.

105. *Callichroma virens.* Of this magnificent insect, which I have taken also in Alabama (U.S.), two specimens occurred in Jamaica, both of them much larger and finer than my American specimen. The first was taken resting on a projecting twig of a tree overhanging the Hampstead Road, June 24th, pretty high up. The other was brought me from the woods behind Bluefields, on the 18th July. Both were strongly fragrant during life.

[To be continued.]

XL.—*On the* Ventriculidæ *of the Chalk; their classification.*

By J. Toulmin Smith, Esq.

[Concluded from p. 295.]

Genus Brachiolites.

Character. Shape and size very various, but always much lobated or branched: internal cavities of lobes and branches always communicating: extremities closed or open: membrane forming the wall sometimes plain sometimes folded: margin of wall thinned or rounded off to an edge: membrane of wall polypiferous on both external and internal surfaces.

Departing altogether from the forms hitherto examined, the present genus is characterized by its lobated or branched divi-

sions*. These divisions communicate internally, either by opening directly into each other, or by opening into a central cavity which they surround.

This genus therefore presents the Ventriculidæ in a new light. With far less of the intricate complexity of fold of membrane which is found in the other genera, it exhibits what may, in contradistinction, be called a *convolution* of membrane varying greatly in different species. And that this "convolution" is a distinct thing from the "fold" already noticed will be evident, should its essential distinctness be not otherwise recognized, from the fact that several species have the fold as well as the convolution. In the descriptions which follow, the fold and the convolution will be distinguished as the *primary* and the *brachial* fold.

This genus, like each of the others, will be found to have all its modifications adapted for the purpose of maintaining strength and stability of form and the free access of sea-water. We shall find some contrivances for these purposes of singular novelty and beauty; and it is upon the marked distinction of two groups in one general arrangement for ensuring to the whole polypiferous surface a full and constant supply of the grand element of the existence of the creatures that the sectional division of the genus is founded;—the one section having the separate lobes of such size, or so arranged with reference to a central cavity, that one main† entrance afforded sufficient access to the sea-water; those lobes in the other being so extended, or so arranged with reference to each other, that additional means were needful for that end.

The roots do not, in general, differ in this genus from the same part in the others; but I shall have occasion to call attention to some special and very remarkable contrivances in the arrangement of this part.

The forms are all well-defined; and though, like *Ventriculites*, specimens of such species as are not of great rarity are found of various sizes, there is little danger of confounding any two of the species unless in a very fragmentary state. As to the question of growth, the present genus may be considered, from the fact just mentioned, to stand on the same ground as the genus *Ventriculites*.

Different forms of this genus are found in the Upper, the Middle, and the Lower Chalk, and even in still lower beds of the

* See pp. 46, 206 *note* ‡, and 293.

† The very beautiful arrangement of *B. angularis* will be found to be one of those interesting apparent (at first sight) exceptions which prove a rule, the main access being through the central cavity, and the lateral perforations ensuring only the full and free *circulation* of the water entering, by that main access, the cavities of the arms. The contrivance in all the group *Aperti* is of a very different character. See *post*, p. 361.

cretaceous series. I believe only one, *B. digitatus**, is strictly common to all the beds, and that undergoes a modification of character in the lower ones. Some of the most marked forms are, as far as present observation has extended, peculiar to the lower of these beds.

§ *a. Operti.*

Brachial folds closed at extremity.

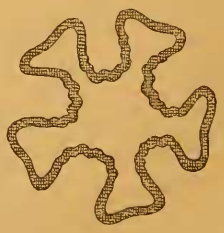
1. *Brachiolites tuberosus.* Pl. XV. fig. 3.

Membrane having an irregular and generally slight primary fold: brachial fold arranged subspirally around a wide central cavity, and at rather distant intervals, in tuberous sacs, broad and flattened at the head, with slight depressions in the middle of the head.

Of this remarkable species I am fortunate in possessing four well-marked specimens, all of which were found by myself, though in very distant parts of the country, and they are the only specimens I have ever seen. The form is striking. Rising from, apparently, a very short root, it attains a considerable height, one of my specimens being upwards of three inches high. The sacs usually project about four lines from the central cylinder, and are about four lines wide, though sometimes more, at their broadest part. They open by a broad and trumpet-shaped mouth into the central cavity, which is wide and open at the top. Thus the access of sea-water is freely maintained.

A transverse section gives the accompanying figure, which will be at once distinguished from that seen in a similar section (see fig. G, p. 289) of *Cephalites capitatus* or of any other of that genus.

Fig. M.



The figure (3. Pl. XV.), which is from a specimen carefully developed from the chalk by means of the needle, gives a complete idea of the species. A large part is broken away, and thus the inside, as well as the outside, is cleared out and displayed. Being, however, developed by this means, and the specimen being one in which the oxide of iron very greatly abounds, the primary fold is hardly to be seen. A careful comparison of this with other specimens shows that that fold was, like that of *Ventriculites impressus*, irregular; usually slight; but occasionally deep, at any rate in that part of the membrane which forms the central cylinder.

The remark already made, in describing *Cephalites campanu-*

* See Ann. and Mag. Nat. Hist. vol. xx. 1st Ser. p. 337, and *ante* p. 38.

latus, as to observations upon the processes, applies equally to every species of the present genus. Enough, however, can be detected to determine the fact of their presence.

This species must, in its recent state, have been singularly striking. It is difficult, indeed, to conceive anything more beautiful than must have been its exterior with each of its regularly ranged lobes covered with its myriads of living polyps and their ever-active tentacles.

All my specimens are from the Upper Chalk.

2. *Brachiolites elegans.* Pl. XV. fig. 4.

Membrane simple and without any primary fold: brachial fold beginning almost at the acute base, and rapidly increasing in broad and swelling lobes closely arranged round a central cavity, and terminating in a simple and regular crown, open at the top, and which, rising from the midst, reaches to a considerable distance above the highest lobes, and is of about half the diameter of the whole body.

This form is, in its fossil state, frequently so beautiful that I have hence chosen its specific name. The effect is heightened by the fact that the root of this species is usually long, and often maintains the same diameter for a height of nearly two inches.

The primary membrane is exactly similar to that of *Ventriculites simplex*: the brachial folds are deep and broad, their inner surface being freely exposed to access of sea-water from the large internal cavity. The crown is one of the most remarkable features of this species. It is regular and plain; springs from the lower edge of the most deeply folded lobes, and rises, unbroken, to a clear and even margin. A glance at fig. H, p. 291, illustrative of the fold of *Cephalites campanulatus*, will aid in understanding the anatomy of the present species; broad convolutions here replacing the plaits seen in that specimen, and the crown being always straight-sided, and never, I believe, assuming a funnel form. Nothing can show more convincingly than this peculiar crown, that the forms of the Ventriculidæ are not merely arbitrary massings of an amorphous or simply cumulative organism, or mere examples of "vegetative repetition," but that there was a type appointed to each which it should attain, and each having its special adaptations. In perfect specimens this head is never wanting, though it is rarely, if ever, to be seen without the aid of the knife; whence it is that it has never, so far as I am aware, been heretofore observed.

The species appears to be characteristic of the Upper Chalk.

3. *Brachiolites convolutus.* Pl. XV. fig. 5.

Membrane coarse in texture, simple and without any primary

fold: brachial fold developed very rapidly from the base, in broad and deeply undulating convolutions, so deep as to leave no regular central cavity; most prominent surfaces much flattened, and spread laterally till those of adjoining convolutions meet and unite in many places, often presenting, towards the lower part of the whole, a continuous surface.

This species displays many peculiarities. The structure of its simple membrane seems coarse, that is, the squares are larger than in any other species of the Ventriculidæ. The root is exceedingly short. The most curious point, however, is the union of the flattened prominences of the convolutions. A reference to fig. M, p. 354, will show, in *B. tuberosus*, a disposition to flattening of the most prominent part of the convolution in that species, and will make the nature of the present fold easily understood, where that flattening is so much more extensive that adjoining convolutions meet and unite*. This peculiarity was important in the present species on account of the great depth of the convolutions, which would, without it, have been more liable than in *B. eleyans* and other species to be displaced, and so injury to have happened to the polyps. But a curious phænomenon is often presented in consequence. The flint,—which, from its specific gravity, would always lie, when fluid, near the sea-bottom,—was attracted round the base of the specimen, but, the surface there being usually continuous for a considerable distance, access to the lower part of the inside seldom took place, unless the siliceous fluid was very abundant; any silex attracted towards the inside† in the manner before suggested (p. 85) being specially attracted by the convolutions interposing before it reached the base, solidifying there, and thus preventing the flow of other fluid towards the base. Hence, on the decay of the animal matter, a large hollow was frequently left in the flint, which is often now found only partially filled up by chalcedony. Such flints are cup-shaped, very regularly rounded below, and have a flat top. Near the edge of that top a continuous line is usually found, showing the place of the united membrane. Within this are seen traces of the convolutions of the

* This outer surface, where the polyp-skin is preserved, which very rarely happens, may sometimes appear as if apolypous. A very careful comparison of all the specimens I have on which remains of this membrane are found, leads me, however, to the conclusion that this is not the fact; but that, the membrane being coarser than usual, the polyp-cells, though present, are not so clearly preserved as in some other species.

† The access of the liquid chalk was often made equally difficult by the collapsion, after death, of some of the lower convolutions on one another. Hence we find the bases of specimens enveloped in that substance often hollow like those in flint. Some deposit of chalcedony has often taken place in those hollows, as in the hollows of the flints.

brachial fold which attracted and retained the siliceous fluid in its descent towards the base. Fig. N is a small specimen of this kind, instances which are not uncommon in some places.

Fig. N.

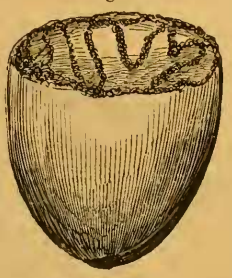


Fig. 5. Pl. XV. represents a specimen which has been longitudinally divided, and has afterwards had the convolutions cleared out by the needle. The white central parts, round the entire edges of which the structure is seen, are the only parts where the true central cavity is cut, notwithstanding the section. The depth of the convolutions will be clearly seen. It will also be observed that there are several places where the flattened convolutions do not unite, thus leaving ample means for the free admission of sea-water to bathe the whole inner portion of what is really the external surface of the membrane, though so much surrounded by the overspreading flattened, and thus actually outer, surface. The true inner surface is bathed by means of the access of water through the upper part in the usual way.

Specimens vary greatly in size. I have them from an inch to at least eight inches in height. The height to which the flattened outer surface is continuous varies in different specimens, being, as might be anticipated, greater in large ones. It is sometimes much greater on one side than on the other, a circumstance, however, which, in the living creature, would not at all interfere with the free access of the sea-water, inasmuch as the communication was free all around within and under this expanded continuous surface.

The species is found both in Upper and Middle Chalk.

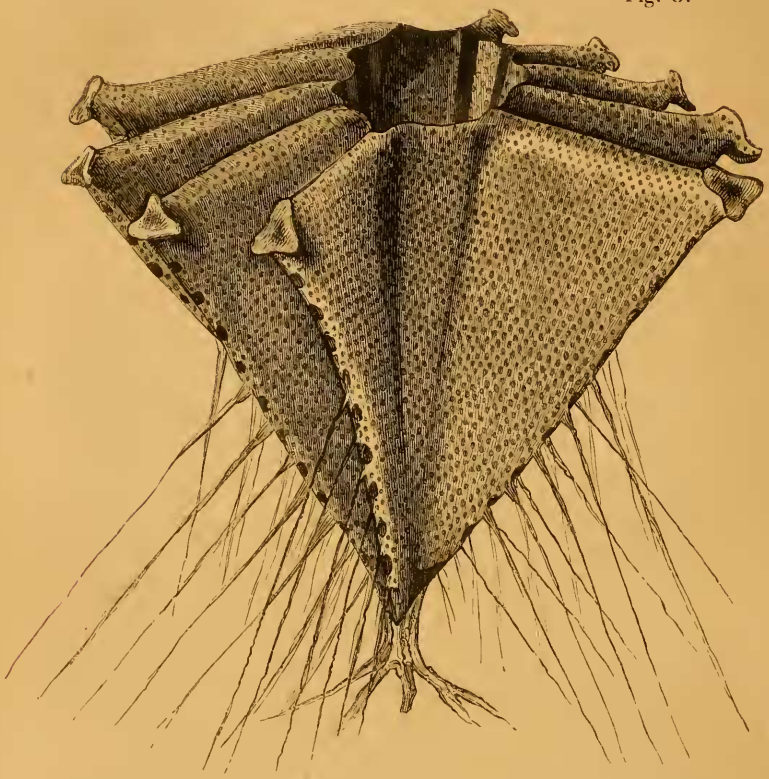
4. *Brachiolites angularis.*

Membrane exceedingly fine in texture, having a primary fold of minute and corresponding depressions arranged in more or less exact quincuncial figure: brachial fold expanding very rapidly into a varying number of arms opening into a central open cavity; each arm having the two walls parallel and flat; closed at upper and lateral edges; terminating at the external angle in a broad triangular lip depressed in the middle; and having at regular intervals, along its lateral edge, complete perforations, between which distinct and single root-fibres are attached to the membrane at intervals from the base upwards.

This is certainly the most extraordinary and interesting of the whole family of Ventriculidæ. It presents some points of such

remarkable structure as must excite the astonishment and admiration of every earnest inquirer.

Fig. O.

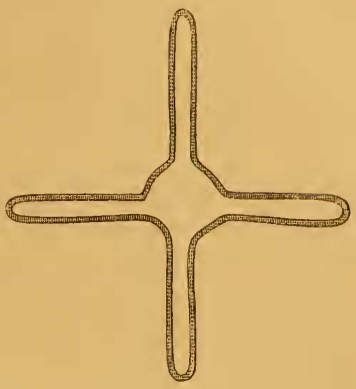


Few fossils have given rise to more varied conjecture than this. A fragment of a specimen found in an unusual condition by Dr. Mantell was originally figured by him under the name of *Ventriculites quadrangularis*. He subsequently abandoned that view,—showing that it had been adopted without the guide of any definite principle,—and, for what reason it is difficult to imagine, and none is stated, placed it among *Flustræ**. Others have amused themselves by discovering analogies to the foliaceous sponges. Remains both in chalk and flint, which had apparently escaped Dr. Mantell's notice, or whose connexion with his figured specimens was at any rate not perceived by him, have even been placed by collectors among the *Asteriæ*.

The form in which the species is necessarily most usually found

* Ante, p. 71, *note**.

Fig. P.



is seen in the accompanying figure. This can, in itself, give little idea of the form or nature of the recent animal. I have a specimen of this aspect nine inches across. Anxious to ascertain the true nature of this remarkable appearance, of which no explanation had ever been even offered, I carefully collected every fragment I could find, until I was led to infer a relation between certain flat and unconnected surfaces, sometimes found, and these markings. I was fortunate at length in obtaining two specimens, each of very large size, and which exhibited on one end the aspect of fig. P, and on the broad side, and in continuous connexion with one of the lines of that peculiar marking, an entire and unbroken surface of many square inches in extent. It became obvious that the inference already made had been correct*; that these markings were caused by the transverse section of a membrane very deeply folded up. I then had recourse, as in other cases, to dissection, in order to ascertain the entire form and habit of the creature, which no specimen developed in the ordinary way could ever show. The extreme fineness of the membrane, and the great depth of the brachial fold, made the task a very difficult one. Having, however, succeeded in several instances, I have been able to restore, from specimens thus cleared out, the beautiful and extraordinary form seen in figure O, a form of animal life seldom if ever exceeded in beauty and striking evidence of design and adaptation†.

The wall of this species is exceedingly thin and delicate, the

* These specimens had been shown by me to several friends, and my inference of the habit of the animal, with a model in paper of what I conceived its form to be, explained to them long before the importation of the 11th livraison of Michelin's 'Iconographie Zoophytologique' (see ante, p. 80). Plate 30 of that work became an interesting illustration of the present species, though giving little idea of its true character, and none whatever of its habit, on neither of which points do the accompanying descriptions afford any real aid. The character of the surface is there very imperfectly represented, and the magnified views are not truthful, which they could hardly be since that author had no idea of the true structure of this class of fossils.

† This figure, as well as all the other woodcuts illustrative of the present subject, has been executed, with great care and faithfulness, by Mr. Frederick Gyde.

squares being smaller than in any other species of the Ventriculidæ. Its membrane is folded up in very small depressions, after the manner of *Ventriculites quincuncialis*, but very much smaller, each depression being rarely more than the sixth of a line in diameter, often less, and usually of an oval form. The plaits may generally be easily traced, as, though these folds assume a quincuncial arrangement, it is usually easy, on a large surface, to trace the fan-like expansion of certain lines,—the lines of the typical plait. The squares being smaller than in other species of Ventriculidæ, the whole thickness of the folded membrane does not exceed the twentieth of an inch. The two surfaces correspond as in the section *Simplices* of the genus *Ventriculites*.

Rising from a short and, comparatively to the whole size of the animal, small central root, the fold is sometimes found for a short distance assuming a tubular form, but it generally puts on, very speedily, its characteristic brachial fold into narrow flat triangular arms. These folds vary greatly in number. The specimen above figured has ten arms, but that number is very uncommon. I have even specimens with only two, but I consider them as abnormal. The arms do not always, though generally, start from exactly the same point. This is the case with the arm on the right of the above figure, as well as with some others the bases of which cannot be seen in the present position of that figure.

Spreading out, sometimes to a very great, sometimes to a very small size, the angular fold terminates, at the top, not in double parallel edges as might have been anticipated, but with the edges united and rounded over as at the lateral margin. Each arm is thus closed on all sides except where it communicates with the central cavity, which is, normally, open at the top. The upper and lateral margins of each arm consequently form with each other an acute angle. Those margins are usually straight; those at the top being also often horizontal, and those at the sides sloping regularly down from their extremity to a point at the base. Instances are found, however, in which these margins have a symmetrical wavy outline. At the extreme outer angle of each arm there is further added a curious triangular expansion, not unlike the expansion at the extremity of each sac of *B. tuberosus*. This lip, as it may be termed, and which, like all the elevations on *Ventriculites mammillaris*, *B. tuberosus*, &c., is hollow within, is concave at the aspect towards the spectator.

It will be understood from this that, between the two walls of each lobe, there is an open space, narrow and of even width throughout. The communication between the central cavity and these arms being therefore not wide, though continuous, the extent and narrowness of these arms struck me for a long time as

likely to offer some difficulty in the way of the free circulation of the sea-water. Confident however that, if my interpretation of the nature of these animals were correct, the means of free circulation must exist and might be discovered, I resumed the examination with an increased series of specimens. The result was the strengthening of all conclusions as to the physiology of the whole family in general, and of this species in particular, by the discovery of a contrivance by which this end was perfectly effected; a contrivance which, for its novelty and simplicity, may well claim the inquirer's attention.

Equidistant, or nearly so, along each *lateral* margin, I found what at first I took for a larger form of depression, but which, on dissection, I found to be actual perforations* through the membrane. These are found present from near the root to the extreme angular expansion already named. A comparison of many specimens satisfied me that these perforations are never absent; that they are always ranged in the same way, and that their size is proportioned to that of the entire animal and to the width between the walls of the arms. They are usually circular, sometimes oval. They vary from half a line to two lines in longest diameter, seldom however attaining this last size.

It became at once evident that this simple provision could have but one end; but that that end it would fully effect. That end was the fulfilling of the very purpose whose incompleteness had before been felt. A constant access and circulation of sea-water would be maintained over all the inner surfaces of these lobes, deep and narrow as they are; the water, admitted at the opening of the great central cavity, coursing out, by the continual action of numberless ciliated tentacles, through these marginal perforations. And herein it is that these perforations differ from those in the group *Aperti*, and do not bring this species within that group. The large central opening was amply sufficient, in this case, for the admission of sea-water, but the peculiar form of the arms interposed difficulties in the way of its free change and circulation, which is equally necessary to the well-being of these creatures. Hence this beautifully simple contrivance for the water, admitted by the central orifice, to pass out through these perforations. In the group *Aperti*, on the other hand, each perforated lobe offered the principal, if not in every case the only, means of both access and circulation of the

* In some of Michelin's figures traces of some of these are found, which, when their nature is known, will be recognized, but which, as they appear in those figures, suggest nothing but irregular depressions: they attracted, indeed, no attention of that author, but, in his descriptions, they are wholly unnoticed, the margins being only said to be,—in the same words as the "superficiebus laminum,"—"*perforatis*," which, as applied, is erroneous.

sea-water, just as in any single specimen of *Ventriculites* or *Cephalites*.

But the contrivances in this species to secure the well-being of the myriads of its tenants, and so strikingly indicative of design and adaptation, do not end here. Thin and delicate as the wall is, though greatly strengthened by the fact of the upper as well as the lateral margins of each lobe being closed, the currents, small as they would be, caused by the streams continually pouring out of these lateral perforations, or lungs as they may well be called, might tend to displace the form;—a matter of peculiar danger in species having such extended surfaces in such close apposition, their distance seldom exceeding one line. Besides this, such broad flat surfaces as the lobes or arms here take would offer so much resistance to the slightest impulse that the walls would be more liable than those of other species to suffer displacement; while there is no membrane, as in *Cephalites*, stretching across and attached to each to secure them in position; a contrivance indeed which, though so admirably adapted to all cases in which it is found, the length and depth and entire distinctness of the arms would, in this case, have rendered but very imperfectly effectual.

To secure the animal against such dangers I have further found that, while the central root* is comparatively small, merely acting as an anchor, there depended a single root-fibril from between each of these perforations to a considerable height†, on all sides of the entire animal. By these then was it maintained securely in shape and in position. These depending fibrils acted exactly like the

* In an earlier page, 91, contrasting the *Actiniæ*, which are locomotive, with the *Pennatulidæ*, which are, according to the better opinion, not so, but which are permanently fixed in the soft mud, I suggested that the Ventriculidæ might possibly combine both these qualities, and have a locomotive power, fixing themselves firmly, during pleasure, in the soft mud. However difficult it may be to arrive at certainty on such a point, the inquirer will probably be inclined to acquiesce in the doubtfulness with which this suggestion was offered, after considering the very peculiar arrangement of roots in the present species. The roots of this family of compound animals fulfilled the same purpose as the peduncle of the *Terebratula*. They differ indeed in structure from the latter,—for the opportunity of examining which, in the recent state, I am again indebted to the kindness of Prof. Owen,—but, in this respect, the *byssus* of the *Pinna*, with an analogous function, differs yet again from both. But it is a curious and important fact that the roots of Ventriculidæ are never found attached to rock or shells, though shells are often *attached to* parts of the surface of the body and roots: nor have the minutest shells ever penetrated the substance of the body, as they continually do in sponges.

† How high it is almost impossible to ascertain. It has been with the greatest difficulty that I have ascertained the fact at all, as it is only by following the small fibril with the knife that its presence can be detected or its direction traced.

ropes of a tent, by which alone it is securely kept in a position which, swinging on its single central support, it could not otherwise sustain for an instant*.

Such are the normal characters of this very curious and interesting species. As was to be expected in so delicate a species, specimens are, not unfrequently, found exhibiting abnormal forms; owing either to displacements of the dead mass before or during the process of fossilization; or, sometimes, to incomplete development of the living mass, or accidents to the living animal,—accidents to which, from its delicacy and remarkable form, it would be peculiarly liable. Thus I have a flint ten inches in length covered with irregular markings, but in which may I think be clearly traced displaced portions of an individual of this species. I have similar specimens in chalk in which it appears clear that the originally flat arms have been tumbled and bent over upon one another in confusion. I have myself collected more than one specimen which would seem never to have had more than two of the flattened arms. In such cases compensating provisions are found; and, there being no large central cavity, the lateral perforations are found larger than usual, and on both edges of what thus becomes one elongated double fold. I have another most interesting specimen, in which the opening of the central cavity is in an abnormal position, namely on one side; but still it is there present in all its completeness, thus showing the necessity and the presence of some compensation where any abnormal conditions exist. There is, indeed, no species among the Ventriculidæ which bears more conclusive evidence to the truth of the views heretofore expressed as to the character, affinities, and habits of the recent animal than does *Brachiolites angularis*.

I cannot conclude the account of this species without expressing the strong feeling which its examination impresses of the wonderful variety, and always completeness, of the contrivances by which nature has effected her ever-present purpose of securing the well-being and permanent safety of every creature she has made. The theorists on *mere*† "*Vegetative Repetition*" and on "*Progressive Development*" will find themselves equally at fault in the examination of this species. There is no form which the naturalist can study with greater interest, admiration and instruction than that of *Brachiolites angularis*.

This species is found in both Upper and Middle Chalk.

* The reader will recal the description of an abnormal form of root already given (p. 92). That specimen is of the genus *Ventriculites*. What is there abnormal becomes a special character in the present species.

† This word is used advisedly, to distinguish those who thus theorize from those who philosophically inquire into the important questions of *serial homologies*.

§ *b. Aperti.*

Brachial folds open at extremity.

1. *Brachiolites foliaceus.* Pl. XVI. fig. 1.

Membrane simple and without any primary fold: brachial fold variously winding and irregularly anastomosing, and thus forming irregular but close and connected sinuous cavities, with rounded, but irregularly arranged, external openings: mass rising to a considerable height; expanding slowly from root, and the whole maintaining, throughout, a narrow diameter.

The style of fold of this delicate species is very similar to that of the recent *Eschara foliacea*. The form assumed by the whole mass differs however materially. Instead of spreading horizontally, the habit of *B. foliaceus* was to rise perpendicularly. It sometimes attained six inches in height, but seldom more than an inch in width at its broadest part. The external openings in this species also differed materially; those openings being usually separate, and circular or oval in form, not irregularly running into each other as in *E. foliacea*.

Fragmentary portions in flint or chalk may readily be distinguished from those of any preceding species by the greater delicacy of the membrane and closeness of the brachial fold. The upper part of fig. 1. Pl. XVI. shows the appearance displayed on a vertical section; while the lower part of that figure shows the external appearance of the fossil when entire.

The close anastomosing of the brachial folds of this species must have given great strength to the whole body; while the freely communicating cavities would allow constant access and circulation of the sea-water.

I have a specimen in which the whole animal part is converted into iron pyrites and the cavities are perfectly clear of all matrix.

The species is found in Upper and Middle Chalk.

2. *Brachiolites racemosus.* Pl. XV. fig. 6.

Membrane having a rather deep primary fold, round, and of nearly equal width the whole depth of the fold, and arranged in quincuncial figure: brachial fold beginning at some distance from the base, and running in narrow and short but regular cylinders ranged subspirally round a small central cavity at rather distant intervals.

This species differs essentially from the last in having a deep primary fold; in having a distinct central cavity, though varying in size, into which each of the brachial folds opens; and in these

last being distinct*, and regular in form and arrangement. The term *racemosus* seems peculiarly expressive of the character of this species. The perfect animal rose on a rather high stem. I am fortunate in possessing a specimen in flint, from which the fig. 6 on Pl. XV. is drawn, with the stem and roots entire, a condition in which the members of the present section are very rarely found. I have another specimen in which the processes are very conspicuously seen, also an exceedingly rare circumstance in specimens of this genus.

The wall of the brachial fold is full a line in thickness, often more, owing to the depth of the primary fold, which much resembles that of *Ventriculites quincuncialis*. The central cavity is usually very small, the access of sea-water being abundant, and its circulation free, by means of the open short cylinders which the brachial fold assumes. Occasionally the central cavity is wide however; though the opening into it is not, even then, proportionably wide, a fact which might have been anticipated.

It would be difficult to confound this species with *B. tuberosus*, though the general habit is the same. The primary fold, and the nature of the lobes, open at the extremity, and much larger than those of *B. tuberosus*, at once distinguish the two†.

All the specimens which I have seen of this species are from the Upper Chalk.

3. *Brachiolites digitatus*. Pl. XVI. fig. 2.

Membrane having a deep primary fold of regular quadrilateral and rectangular form, usually more or less oblong, and arranged in tessellated figure: brachial fold branching out irregularly

* I have observed, in one specimen in flint, an indistinct appearance as if two of the cylinders adjoined at one point. If it be a true anastomosis (which I doubt), it is a very rare exception. No symptom of it has been seen in any other instance.

† Through the kindness of Mr. Wetherell I am in possession of one very interesting specimen of this species, strikingly illustrative of the truth of the views expressed in the early pages of these sheets as to the peculiar state in which silicified specimens are found. Each of the cylinders is separately encased in a thin coat of flint, so that the whole was actually taken, by a distinguished palæontologist, for the silicified fruit of a *conifer*. In touching on this subject I cannot forbear citing a passage from Humboldt's 'Cosmos,' published long after my remarks on the formation of flint and on the silicified Ventriculites were written, and which is in direct accordance with, and therefore supports, the views advanced by me on both those subjects. That writer alludes to the siliceous-shelled infusoria as being universally found in sea-water, "*although* the chemical analysis of sea-water has not shown *silica* to be one of its essential constituents; and *it could only indeed exist in water in a state of simple mixture or suspension.*" (Vol. i. p. 341.) This, however, is a state of things which Mr. Bowerbank has expressed himself unable, "by any stretch of the imagination," to "conceive." 'Ann. and Mag. Nat. Hist.' vol. xix. 1st Ser. p. 260.

into long and wide regular cylinders either grouped near the base or dividing off one from the other.

This species differs most essentially from the last. Both primary and brachial fold altogether differ. The former exactly resembles the fold of *Ventriculites tessellatus*. The latter is very peculiar. It often displays a group of cylinders radiating out from near the base just like the outstretched fingers of the hand; and the length and thickness of the cylinders increase the resemblance. Hence the name. It is often found however under a modification of this form, rising to a considerable height, and one branch rising out of the other, at considerable distances, as it increases. In each case alike the cylindrical cavities of all the branches open into each other, and there is no true separate central cavity into which they open. The separate branches form exceedingly regular cylinders, and the primary fold is marked on each with perfect regularity. The margin goes off to a round edge, as will be seen in the figure.

The species cannot be at all understood, or even detected, without careful clearing out with the knife and needle; since its very nature, like that of every other species in this section, prevents it ever coming out of the matrix entire by any accidental fracture: beautiful fragments of it are, however, sometimes found.

The species is found in the Upper and Middle Chalk. A form essentially the same and of the same habit is sometimes found in the lower chalk and in the chalk marl and greensand*. In all the specimens from these latter beds which I have seen the thickness of the wall is however much greater, and the diameter of the branches also rather greater than in specimens from the Upper and Middle Chalk, a fact which it is interesting and important to notice as connected with the stratigraphical distribution of these fossils, though I do not conceive these minor characters sufficient to justify, at present at any rate, and until their constancy is fully established, a distinct species or even variety for those lower forms.

Among the Mount Rhanden specimens in the British Museum are individuals identical in general character and habit with the last-named modification of *B. digitatus*.

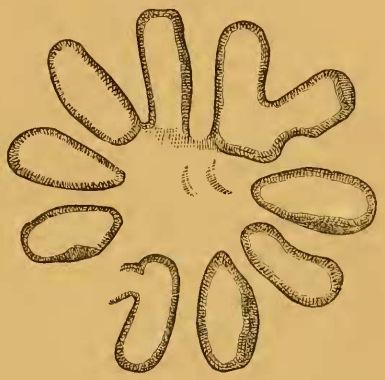
4. *Brachiolites tubulatus*. Pl. XV. fig. 7.

Membrane having a more or less slight, but close, primary fold, without any regular figure: brachial fold in narrow tubes increasing in size and length from the base upwards, and closely ranged round a central cavity; each tube narrowing at the mouth.

* See ante, p. 354.

This form will readily be distinguished from every other not only by the difference in the primary fold from that of any species which approach it in the character of the brachial fold, but in the essential character of that brachial fold itself. The narrowness, in comparison with the length, and the close setting of the tubes, are together found in no other species. The accompanying figure, which is a transverse section of a specimen of this species, near the top, and just therefore missing the central cavity, could be presented by a similar section of no other species. It seems to me that there is generally no marked distinct opening to the central cavity, but that it is surrounded on all sides by the tubes. In fig. 7 of Pl. XV. the upper part was cut away before it came into my possession, but the wall of the cavity is, in that specimen, rounding inwards, and not expanding.

Fig. Q.



It is important to notice that each brachial fold is distinctly tubular and prominently projecting, and that its termination is slightly contracted, in the present species, two characters in which it essentially differs from *B. labrosus* and *B. fenestratus*, and characters which must obviously have materially affected the access and circulation of the sea-water. The central cavity into which those tubes open is another character to which the last remark strongly applies, and is a character also at once distinguishing this species from *B. fenestratus*.

This species is from the Middle Chalk.

5. *Brachiolites fenestratus.* Pl. XVI. fig. 3.

Membrane simple and without any primary fold: brachial fold in narrow tubes anastomosing and opening into each other in not very regular figure, but in several vertical and horizontal planes, leaving interspaces between them about equal to their own width: each tube rounding at mouth and projecting slightly beyond the plane of the most external range of the anastomosed mass.

The description will at once show wherein this species differs from the last. A single fragment of tube may be mistaken, as the primary fold is not strikingly marked in either, and the size

of the tube is the same in each. But masses of the two cannot be confounded, and the specific distinctions, as noticed in treating of *B. tubulatus*, are very important. It should be further noticed that, in the present species, there is not that variety in the size of the tubes which, as seen in fig. 7. Pl. XV., is found in *B. tubulatus*.

A certain degree of regularity is generally found, on careful observation, in the arrangement of the anastomosing tubes; that arrangement bearing often a near resemblance to regular square lattice-work. This arrangement extends both in the horizontal and vertical plane, as endeavoured to be represented in fig. 3, Pl. XVI. Specimens sometimes attained a large size.

Both this species and the last are very beautiful fossils when they can be obtained in any degree of perfectness. This however is extremely difficult, owing to the small branching arms of which each is made up. The inquirer may, unless great care is bestowed, and very cautious dissection made, easily mistake for them some of the markings often found on accidental fracture of chalk and flint, and on the outsides of flints, and which are really caused by *B. foliaceus* or other of the sinuous species. Oblique fractures take very indeterminate forms.

This species is found in the Chalk Marl and Upper Greensand. I have never seen a specimen from any higher beds.

6. *Brachiolites labrosus*. Pl. XVI. fig. 4.

Membrane having a slight and irregular primary fold: brachial fold variously winding and irregularly anastomosing, thus forming irregular but wide sinuous cavities opening into each other, with slightly projecting wide and irregular openings having entire and rounded margins: mass compact, broad and wide; rising to a moderate height, and subglobose in form.

The description will at once enable the inquirer to distinguish this very marked form from every other. The character of the primary fold resembles that of *Ventriculites impressus*. It is not nearly so close as in *B. tubulatus*, but much closer than is usual in *B. protensus*. The mouths of the cavities rarely open, as in *B. fenestratus*, by a regular cylindrical tube, but are very often elongated or irregular, and more or less constricted near the middle. The margin, however, is in every case entire, and generally spreads outwards, thick and lip-like, whence the name. The figure exhibits these peculiarities, but the size of the plate did not allow space for the representation of an entire specimen.

This species is found in the Chalk Marl and in the Upper Greensand. I have seen it from no higher beds.

7. *Brachiolites protensus.* Pl. XVI. fig. 5.

Membrane having a slight and irregular primary fold: brachial fold in large sinuous tubular masses frequently anastomosing and opening into each other, and with occasional, but irregular, large interstices: mass very irregular and usually spreading horizontally.

This species will perhaps be best understood if the inquirer conceives a number of the arms of *B. digitatus* to be more or less contorted instead of straight, and to anastomose and open into each other instead of always being distinct from each other at all other points than their bases. The tubular folds of *B. protensus* project from the mass not very prominently, but still conspicuously and in every direction. The primary fold differs however, as will be seen both by the description and figure, most essentially from that of *B. digitatus*.

The habit of the mass is the very reverse of being compact like *B. labrosus*; it may best be described as *sprawling*, whence the name; its tendency being usually to horizontal rather than perpendicular extension: it does not seem to have any inclination to assume the globose or any other definite general figure. The mouths of the tubes tend to expand as in *B. labrosus*, while in *B. digitatus* their tendency, where not simply straight, is rather to contract as in *B. tubulatus*.

This species is from the Lower Chalk and Chalk Marl.

I have thus laid before the reader the result of an investigation which has engaged most of the leisure hours of some years. I am too conscious of the disadvantages under which I labour, and the want of qualifications which I possess, to anticipate otherwise than much criticism as to the result of that investigation and the execution of my task. I would only request the reader to remember that the field was an entirely untrodden one and the task a new one,—"a task of no little difficulty in the accomplishment, and one that may fairly entitle him who enters upon it to expect to meet with indulgence*."

I have endeavoured to show the existence, in one, at least, of the great geological epochs, of a widely extended class of animals whose nature,—if the existence of a few of the forms was vaguely known before,—was totally unknown, as also was their structure and all that constitutes the knowledge of an organic being. I have exhibited a structure as remarkable as it is novel. I have shown the extraordinary variety of forms which that structure assumes,—a variety in which one Law of Unity, however, still

* Farre, ut ante, p. 387.

prevails. Numberless illustrations of design and adaptation have forced themselves upon attention in the course of the investigation, and more might have been suggested had it not been feared that the allusion would appear obtrusive.

It cannot be supposed that the forms which have been here described constitute all that existed of this family even in the cretaceous seas. In my own collection are a few individuals as to whose specific identity I have some doubt, but as to which I would wait for further means of observation rather than rashly increase the number of species. Doubtless, now that the structure has been described, and figures and descriptions of such numerous forms been given, some attention will be directed to the subject and other forms be found. From the great extent of the materials on which these observations have been made, it may, however, without presumption, be conceived that the principal typical forms are here included, and that any which may hereafter be clearly ascertained will range themselves easily in one or other of the groups whose characters, general and special, have been here determined.

Many other obscure fossils are found in the chalk, either generally unknown or distinguished by names which impart little idea of vitality to the objects to which they have been attached,—a vitality which it is sought in vain to realize by any descriptions which have hitherto been published. To a more particular examination of some of these, the attention of such readers as have followed with any interest the present inquiry into the structure, affinities and forms of the Ventriculidæ, may, at a future day, be perhaps invited.

EXPLANATION OF PLATES.

[Plates VII. and VIII. appeared in vol. xx. of the first Series.]

Pl. VII. (all in flint except figs. 1, 2, 3, 9 and 12).

Fig. 1. Transverse section of *Cephalites longitudinalis*, pp. 89 & 281.
— 2. Transverse section of *C. alternans*, pp. 89 & 283.
— 3. Oblique section of *C. bullatus*, p. 284.
— 4. Vertical section of *Ventriculites*, showing base of body lodged and ensheathed in the root: the upper part showing the fold of the membrane, p. 88.
— 5 & 6. Vertical and transverse section of the same specimen showing body lodged and ensheathed in the root, p. 91, & see p. 362, note.
— 7. Root seen externally ensheathing body, p. 91.
— 8. Intimate structure of the Ventriculidæ highly magnified, showing square and octahedral structure, p. 93.
— 9. Cast in chalk of this structure, p. 95.
— 10. The octahedral structure very highly magnified, p. 95.
— 11. The dermis or underskin, pp. 95 & 182.
— 12. The epidermis or polyp-skin, pp. 95 & 182. This specimen is broken away at the upper part, showing traces of the structure below.

Fig. 13. The polyp-cells: vertical section highly magnified, p. 188.
— 14. The mode of addition of fibre, p. 93.

Pl. VIII. (all in chalk except fig. 7).

Figs. 4 & 5. Casts showing the places of processes, p. 184.
— 6. Polyp-cells highly magnified, p. 187.
— 7. Root-fibre encrusted with chalcedony, p. 97.
— 1. *Ventriculites simplex*, p. 204.
— 2 & 3. *Ventriculites impressus*, p. 205.
N.B. For *Ventriculites quincuncialis* see Pl. VII. fig. 7, & p. 207.

Pl. XIII. (all in chalk, except fig. 6, which is in flint).

Fig. 1. *Ventriculites muricatus*, p. 210.
— 2. *Ventriculites tessellatus*, p. 211.
— 3 & 4. Different sections of *V. tessellatus*, p. 211.
— 5. *Ventriculites cavatus*, p. 212.
— 6. *Ventriculites striatus*. p. 212.
— 7. *Ventriculites mammillaris*, p. 213.
N.B. For *Ventriculites latiplicatus* see fig. D, p. 215.
— 8. *Ventriculites decurrens*, p. 215.
— 9. Variety *tenuiplicatus*, p. 215.
— 10. *Ventriculites radiatus*, p. 218.
— 11. Section of *V. quincuncialis*, p. 208.
— 12. Section of *V. muricatus*, p. 210.
— 13. Plaits of *V. striatus*, pp. 214, 216.
— 14. Plaits of *V. mammillaris*, pp. 214, 216.
— 15. Plaits of *V. radiatus*, p. 216.
N.B. For *Ventriculites bicomplicatus* see fig. E, p. 219.

Pl. XIV. (all in chalk).

Fig. 1. *Cephalites longitudinalis*, p. 281.
— 2. *Cephalites guttatus*, p. 282.
— 3. *Cephalites paradoxus*, p. 283.
— 4 & 5. Outer and inner surfaces of *Cephalites alternans*, p. 283.
— 6. *Cephalites bullatus*, p. 284.
— 7. Section of *Cephalites bullatus*, p. 284.
— 8. *Cephalites retrusus* (moulded from a cast in flint), p. 285.
— 9. *Cephalites catenifer*, p. 286.
— 10. *Cephalites compressus*, p. 287.
— 11. *Cephalites capitatus*, p. 288.
— 12. *Cephalites campanulatus*, p. 289.
— 13. Vertical section of *Cephalites campanulatus*, p. 292.
— 14. Piece of the matrix from inside of *C. catenifer*, showing projecting parts, which filled the depressions in the living animal, broken away, p. 286.
— 15. Transverse section of fold of membrane of *C. catenifer*, p. 287.
— 16. Plaits of *C. catenifer*, p. 287.

Pl. XV. (all in chalk, except fig. 6, which is flint).

Fig. 1. *Cephalites constrictus*, p. 292.
— 2. *Cephalites perforatus*, p. 294.
— 3. *Brachiolites tuberosus*, p. 354.
— 4. *Brachiolites elegans*, p. 355.
— 5. *Brachiolites convolutus*. The specimen has been vertically divided and one-half cleared out, thus showing the convolutions and the interior, p. 355.
N.B. For *Brachiolites angularis* see fig. O, p. 357.

Fig. 6. *Brachiolites racemosus* : the right-hand portion shows the form of the arms as seen on outside of flint; the left-hand portion shows the root and longitudinal sections of several arms, p. 364.
— 7. *Brachiolites tubulatus*, p. 366.

Pl. XVI. (all in chalk).

Fig. 1. *Brachiolites foliaceus* : the lower part showing the outside, the upper part a vertical section, p. 364.
— 2. *Brachiolites digitatus*, p. 365.
— 3. *Brachiolites fenestratus*, p. 367.
— 4. *Brachiolites labrosus*, p. 368.
— 5. *Brachiolites protensus*, p. 369.

XLI.—*Remarks on the Migrations of* Aphides.

By Francis Walker, F.L.S.

From the great Author all that lives
Its stated boon of life receives.
Ere long again restored to thee;
Each insect too minute to name
Yet owns a portion of thy flame,
Part of thy numerous family.

Resplendent cars of fiery glow
From realms of light to earth below
Thy animated offspring bear;
And when this mortal trial ends,
Again the glorious car attends
To wing them to their native sphere.
Lorenzo de Medici.

In the following notice I have enumerated some of the species of Aphis that migrate at regular periods from one kind of plant to another, or whose food has been partly altered by the cultivation of plants. *Aphis Rosæ* migrates from the rose to the teazel; *A. dirhoda* from the rose to grasses and flags, and the introduction and growth of corn have afforded it a new nourishment, and have consequently modified its habits; and the cultivation of various species of rose brought into this country has also increased its food, and that of *A. Rosæ* and of the three following species: *A. trirhoda* migrates from the rose to the columbine, and this change of food is probably not aboriginal, but consequent on the cultivation of the latter plant. *A. tetrarhoda* and *A. Rosarum* appear to live only on the rose genus. *A. Avenæ* has its first habitation on grasses, and the cultivation of corn has furnished it with a new and abundant source of food. *A. Capreæ* migrates from the willow to umbelliferous plants, and in this case both the winter residence and the summer pasture of the species are aboriginal. The food of *A. Urticaria* is divided between the nettle and the bramble, and both these plants are also original sources. *A. Humuli* lives permanently and aboriginally on the